Title: Inflationary processes in the early stages of the development of the Universe

Authors: Oleg Ilin

Abstract: The inflationary stage of the early Universe is considered. An equation is introduced that combines inflation and the Friedman equation, which describes further evolution. Conclusions are drawn about the stage of star formation, the emergence of the large-scale structure of the Universe and voids.

One Sentence Summary: An idea linking together the inflationary stage of the Universe with Friedmann's cosmological model

Main Text:

Modern theories of an inflating universe (and there are quite a few of them) have been called upon to explain a number of problems arising in the Big Bang theory:

- the problem of homogeneity, or why the Universe was so homogeneous just a second after the Big Bang;
- flatness problem;
- problem of magnetic monopoles.

The theories are quite advanced, but each is based on the idea of a very rapid expansion of the Universe at the initial stage of its inception. This expansion closes the problems of homogeneity and isotropy, which are observed now and do not have an adequate answer within the framework of the Big Bang theory. However, the theories themselves have a number of shortcomings and internal problems. Moreover, the basis of the original reasoning and initial postulates seems simplified.

The inflationary model describes the initial stage of the development of the Universe. A simplified model of inflation can be quite easily obtained from the Friedman equation by modifying it with a correction in the form of a higher derivative with a small parameter. Then the solution of the extended equation will show exponential growth of the boundary layer, namely, in the short initial period of time of the evolution of the Universe. In the future, this solution will asymptotically tend to the solution of the Friedmann equation. The extended equation shows the internal connection between the initial conditions of the differential equation, the appearance of the initial jump and the boundary layer accompanying the inflationary stage of the Expansion of the Universe.

Three Friedmann equations are known

$$\frac{3}{a^4}(a^2 + a'^2) = \kappa\epsilon \, .$$

. Friedmann's equations for a closed Universe.

$$\frac{3}{a^4}(-a^2 + a'^2) = \kappa\epsilon \, .$$

Friedmann's equation for the open Universe.

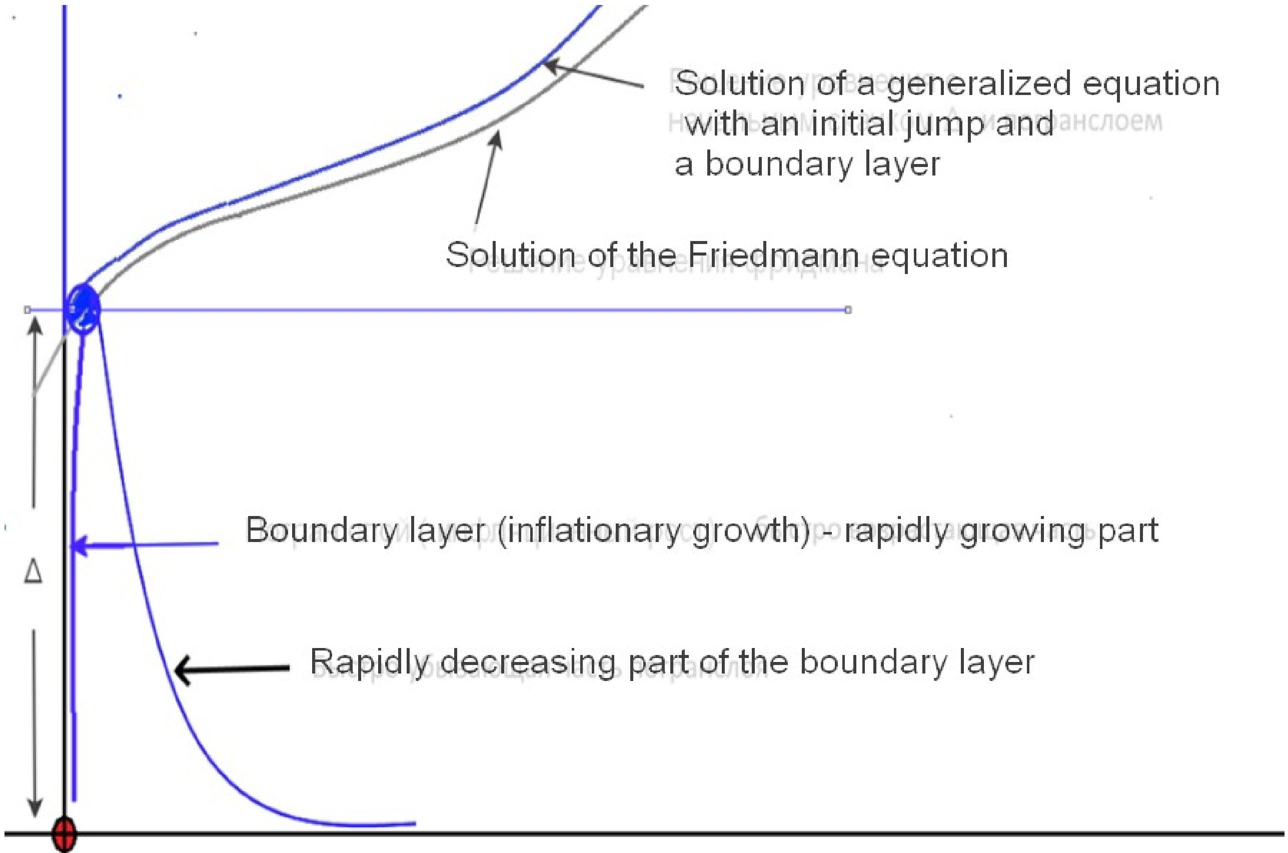
$$3\frac{\dot{a}^2}{a^2} = \kappa\epsilon \, .$$

Friedmann's equations for a flat Universe.

Let us rewrite these equations in general form, introducing additional boundary conditions and a second-order derivative with a small parameter that take into account the quantum correction. Then the modified equations will take the form:

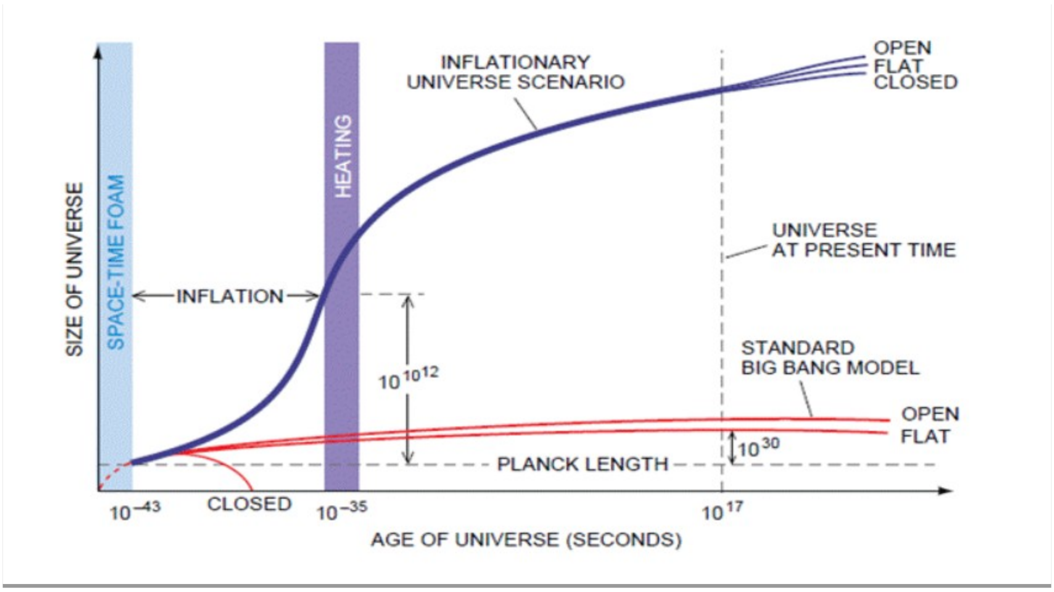
$$L_\varepsilon y \equiv \varepsilon y'' + \varphi(x, y, y') = 0, \quad y|_{x=0} = y_0, \quad y'|_{x=0} = e^{C/\varepsilon}.$$

Studying the differential equation, we see that the solution can be represented in the form of a boundary layer, a sharply and rapidly increasing part (inflation), and a fairly stationary solution, asymptotically approaching the reaction of the ordinary Friedmann’s equation.



$\Delta = O(\exp/C)$ the initial jump that determines the size of the Universe after the end of the inflationary stage

This solution changes the qualitative picture of the inflationary stage than it was before. In particular, exponential expansion is observed both in the inflation stage and in the stationary part.



As is known, the Friedmann equation arises from Einstein’s equations and indicates the expansion of the Universe at certain parameter values. In other words, inflation is a process associated with such a state of the Universe when Einstein’s equations work in it, and quantum phenomena play a secondary role. However, quantum interactions continue, as does the rapid growth of dark matter. According to this solution of the differential equation with an initial jump, the Universe at the initial stage behaves the same for all three models.

In fact, the described technique allows us to build cosmological models of the Universe, removing from the field of consideration the destructive consequences of the Big Bang and mainly the initial singularity.

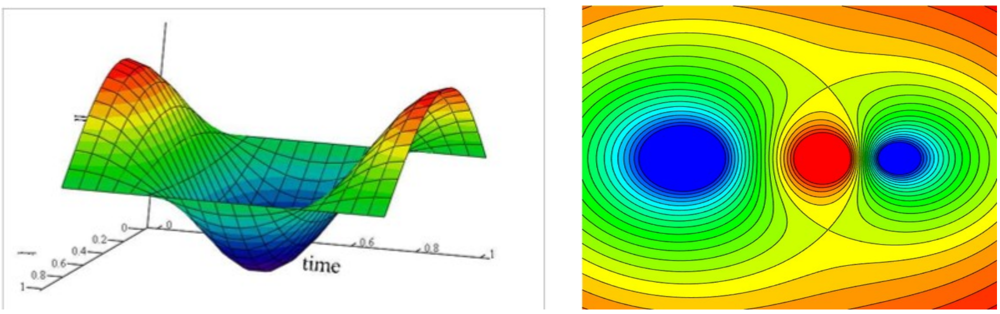
As for the stages before the Big Bang and the evolution of black holes (including quantum ones), they must be described by equations with ultrameasures in the corresponding ultrametric spaces. Examples of such equations in ultrametric p-adic spaces are considered by V.S. Vladimirov and his colleagues.

Having escaped from quantum measurements, the Universe begins to exist within the framework of one form or another of Einstein’s equations, in the formalism of the geometry of curved space, and therefore in terms of the Archimedean metric that describes these curvatures. Given the expansion growth estimate (Part I), the Universe is open and has exponential growth in Expansion. However, in quantum measurements, where general relativity breaks down, non-Archimedean ultrametrics reappears.

Let's return to the modern postulates of the theory of Inflation. They argue that in space, which expands during the inflationary stage, nothing changes except density. However, it appears that the structure of space is changing. As a result of destructive curvatures of space during the collapse of

quantum black holes, dark matter appears in excess. The inflationary process itself stems from the volume of energy of the Big Bang and the strong curvature of the “proquanta” of space in which the energy of the Big Bang was localized. This curvature produces a scalar field with incredible potential energy. The scalar field provides the inflation mechanism or the extreme expansion stage. A decrease in curvature leads to the formation of matter, which in turn contributes to the emergence of gravity, gravitational fields and, ultimately, an increase in the volume of our space.

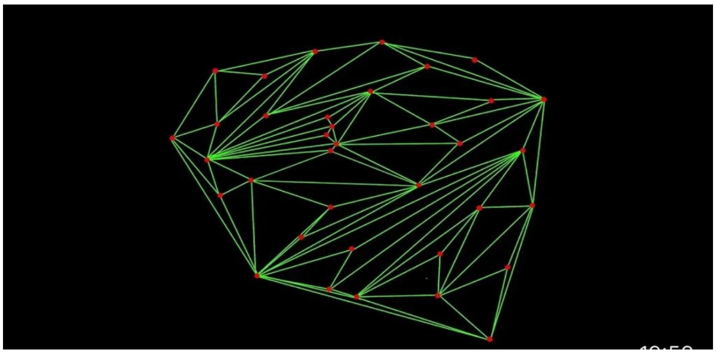
The inflationary stage is the stage of gravitational super-storms. Giant tsunamis of gravitational waves, emerging from the accelerated birth of gravitational fields, began to roam throughout space. Considering these waves in the formalism of hyperbolic equations, we will inevitably come to catastrophes (Petrovsky's features), which will form huge vortices of different shapes. Dark matter, clouds of interstellar gas and dust, interstellar electromagnetic fields and cosmic rays will accumulate in these vortex conglomerates.



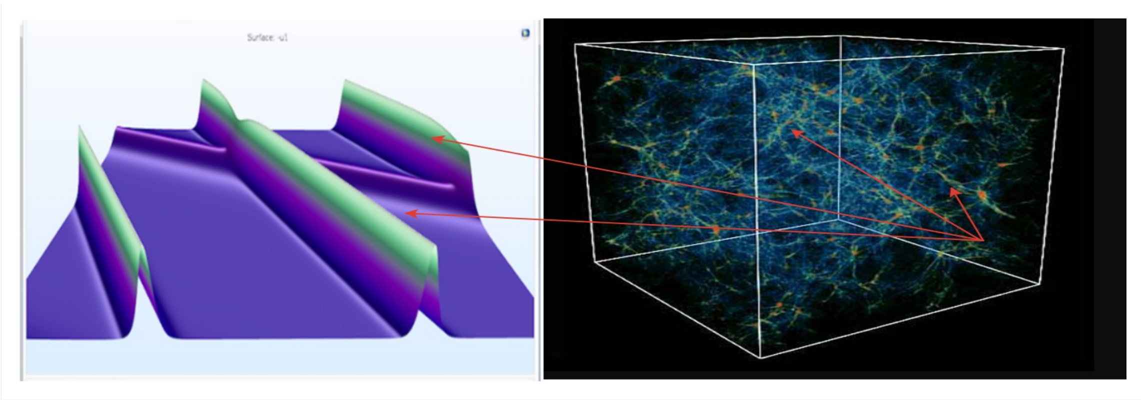
Areas of features: zones with accumulating matter are highlighted in blue, dark matter zones are highlighted in red.

The further process is described in detail by modern science: all the “garbage” accumulating in the vortices triggers the process of star formation. As dark matter forms, it will join these vortices. Representing defects in space, dark matter does not participate in interactions with matter and is not directly included in the composition of stars, but, located in the form of a halo, it keeps the formed Galaxies in a fairly compact state. It is also an obvious fact that the shape and size of Galaxies must correlate with the types of “whirlpools” that create streams of gravitational waves propagating through space.

The remnants of the spin network of “proquanta” determine the large-scale structure of the Universe and explain the appearance of voids. The presence of such formations with corresponding drift and degradation in time is predicted by almost all cosmological models and is called cosmic strings.



The spin network of “protoquanta”, which is the prototype and cause of the appearance of cosmic strings and voids



Large-scale structure of the Universe and voids.